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Radiant heating systems

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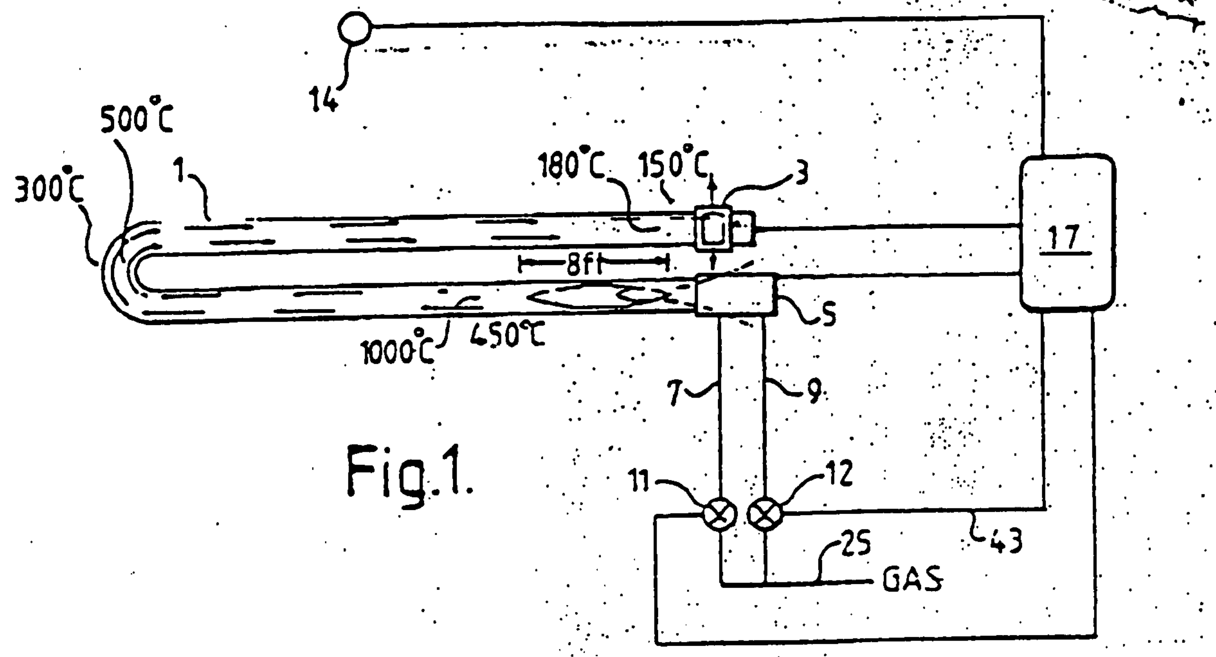

Fig.1.

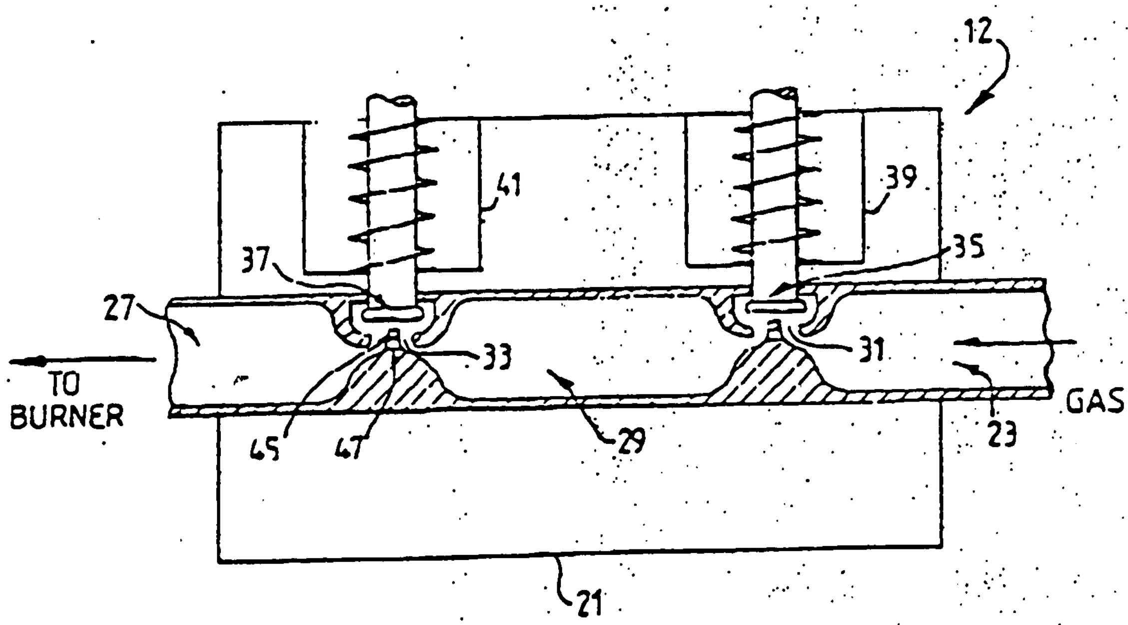

Fig.2.

Radiant Heating Systems

The present invention relates to heating systems comprising at least one tube, a burner for supplying combustion products to the tube, and a fan for drawing the combustion products through the tube. The combustion products heat the tubes to a temperature at which they radiate infra-red energy.

Originally infra-red radiant devices were only used in industrial appliances such as ovens. Such devices radiated energy in the upper infra-red regions. At this stage domestic or industrial space heating devices generally relied on conduction or convection and utilized very little, if any, radiation for heating.

Recently, efficient space heating has been achieved using devices which radiate infra-red energy. Such devices are energy efficient in that they heat directly the objects on which the radiation impinges with little loss of energy to the air between the device and the object to be heated. The object may absorb the radiated energy, conduct it to other objects to be heated, or re-radiate it onto other objects.

Use of infra-red radiating devices can be very energy-efficient, since it can minimise heat losses to the surrounding air, especially roof spaces, and can reduce the creation of draughts.

At its simplest, an infra-red radiant heating system comprises a single tube having at one end a burner and at its other end a fan. The fan draws the combustion products from the burner along the tube, which is thereby heated to a temperature at which it radiates infra-red energy. Generally, a reflector will be mounted adjacent the tube for directing the radiant energy to the area it is desired to heat.

A more compact system can be provided by use of

a U-shape tube. This enables the fan and the burner to be located at the same end of the device, with the bend of the tube at the opposite end. Such an arrangement is shown, for example, in GB-A-1 315 685. It is also possible to mount the fan and the burner in a single assembly.

Use of single tubes, whether straight or U-shape, can be relatively inefficient, since it requires a number of devices to heat a large area. This in turn requires the use of a number of fans, and associated connections and controls.

This drawback can be avoided by the use of a connected system of tubes, for instance of the type described in GB-A-2 102 555. In such a system, a number of tubes are connected to a single fan for drawing combustion products therethrough. The problem within a connected system is that it requires a number of burners in the tubes to ensure that all the tubes are heated to the necessary temperature. To ensure that the fuel is properly combusted in each burner it is necessary to include in the tubes various dampers to regulate the effect of the fan and to ensure that sufficient air is supplied to each burner.

Since combustion efficiency depends on matching air flow rate and fuel supply rate with heater dimensions, it has not previously been possible to modulate continuously the fuel supply rate to match the desired radiant heat output and maintain combustion efficiency.

Therefore most radiant heating systems operate on an on/off basis. This will be inefficient when demand is less than the maximum heat output. During the operation of such systems as shown in GB-A-2 102

555, the burners always operate at a predetermined single heat output.

It is therefore an aim of the present invention to provide a radiant heating system which preferably has an automatically adjustable heat output.

The present invention provides a radiant heating system comprising a tube, a burner for supplying combustion products to the tube, and a fan for drawing the combustion products through the tube, and at least one swirler (or heat transfer plate) within the tube, the burner being connected to its fuel supply through a first aperture and a second aperture of a dual aperture valve, whereby, during operation of the burner, the first aperture provides on/off fuel supply to the burner, and the second aperture controls the rate of fuel supply to the burner.

Preferably the fan is of variable speed to maximise combustion efficiency.

The fuel supply may be variable stepwise, for instance in a high/low fashion, or continuously between zero and a predetermined maximum, by the operation of the second aperture.

It is believed that the present system operates on the following principle, although the Applicants do not wish to be limited by the following explanation.

It is well known that the amount of energy radiated by a body is related to the fourth power of its temperature, i.e. $Q=kT^4$, where Q is the amount of energy, k is a constant and T is the absolute temperature of the body. If the temperature is relatively low, there is very little heat radiated. If the temperature is relatively high, the material from which the body is made may begin to degrade. It can thus be seen that there is only a relatively narrow

band of temperatures in which a radiant heater will produce sufficient radiant heat to be effective in space heating without destroying the material of which the body is formed.

Conventional radiant heating systems have been operated with a preset fuel supply, which maintains the temperature of the majority of the tube within the useful radiating range. However, any attempts to modulate this fuel supply resulted in the temperature of the majority of the tube falling below the useful radiating range. Hence these systems were operated on the on/off principle.

It is believed that in the system of the present invention, when operating at a low fuel supply rate, the combustion of the fuel, in conjunction with the effects of the or each swirler/or heat transfer plate maintains the temperature of the majority of the tube in the useful radiating range, while the high rate of fuel supply can be used to raise the tube temperature a desired amount without raising it above the useful radiating range.

In a preferred embodiment, the dual aperture valve is electrically or electronically controlled. For instance, the opening of both the apertures may be linked to the operation of the fan, whereby they may only be opened when the fan is operating. Their opening may also be linked to a flame detector, whereby they may only be opened when the pilot flame is burning.

The opening of the second aperture may be linked to a thermostat. In one embodiment, the second aperture may be open when the thermostat temperature is below a preset limit and closed when it is above this limit. Thus, the second aperture may be opened to

allow enhanced heating at an initial stage, which is then switched to a lower degree of heating at the preset temperature.

In an alternative embodiment, the opening of the second aperture is variable and is linked to the thermostat whereby its degree of opening is inversely related to temperature within the area to be heated.

The present invention may be applied to straight tube, U-shape tube or continuous tube type radiant heating systems, and may therefore include any of the features, in particular the safety features, used in such systems. Typically the system of the present invention will include at least one reflector for directing heat to the desired area.

The burner of the present system may operate on liquid or gaseous fuel, but preferably operates on gaseous fuel, such as natural gas or bottled gas.

A subjective measurement of the efficiency of a heating system is the "comfort level". This is a combination of many features, such as radiant heat received, air temperature, and amount of draughts. The system of the present invention allows a reasonable comfort level to be obtained at much lower air temperatures than is usual for convection or conduction systems.

For instance, a factory space may be at a temperature of between 0 and 10 °C at the beginning of a working day. Once the radiant heating system of the present invention is set going, with both apertures open, the amount of radiant heat received will be high, the air temperature will be low and the amount of draughts will be low, leading to an acceptable comfort level.

Once the air temperature has reached, for instance, 10°C the second aperture may close, thus reducing the amount of radiated heat received, which

may be becoming less than acceptable to a person in the area. However, the reduction will only occur with the increase in air temperature, and thus maintainence of the desired comfort level will be achieved.

The maintainence of the comfort level can be more readily achieved by use of a continuously variable second aperture, and, if desired, could be manually adjustable.

One embodiment of a radiant heating system according to the present invention is now described ,by way of example only, with reference to the accompanying drawings, in which:

Figure 1 shows the system diagrammatically; and

Figure 2 shows an enlarged view of part of the system shown in Figure 1.

Referring now to Figure 1, the system of the present invention comprises a U-shape steel tube 1. At one end of the tube 1 is a fan 3 which causes a flow of gas in the direction marked by the arrows in the tube. At the other end of the tube 1 is a burner 5. The tube 1 has a reflector (not shown) around it for directing radiant heat to a desired location and a swirler (not shown) for maximising radiant efficiency.

The burner 5 includes a pilot burner, which is supplied with gas along line 7, and an electronic ignition therefor. The burner 5 also includes a main burner, air supplies for the pilot burner and the main burner, and a flame detector for detecting the pilot flame. These are conventional items and are not described in detail.

The burner 5 is provided with line 9 for supplying gas to the main burner. The lines 7 and 9 pass through electrically controlled valves 11 and 12 respectively.

The system includes one or more a thermostats 14, the fan 3, the electronic ignition, the flame detector and the valves 11 and 12, all operatively connected to a microprocessor control unit 17.

The electrically controlled valve 12 is shown in more detail in Figure 2, to which reference is now also made.

The valve 12 comprises a housing 21 having in it an inlet 23 for connection to a gas supply line 25 and an outlet 27 for connection to line 9. The inlet 23 is separated from the outlet by a valve block 29 in which are provided two apertures 31 and 33.

The aperture 31 is closed by valve disc 35 and is normally held closed by spring action but can be opened by solenoid 39 operatively connected to the microprocessor 17 by line 43

Aperture 33 includes a web 45. In normal use, to provide a low flow rate, the aperture 33 is closed by valve disc 37 and is held closed by spring action. However, in this "closed" position gas is able to weep through an orifice 47 in the web at the low flow rate. To provide the high flow rate, the valve disc 37 is moved against the spring action by solenoid 41 which is operatively connected to the microprocessor 17 by line 43.

A valve of this type is commercially available as a "Series 24 Double Valve" from Tenknigas Ltd, of Charleswoods Place, East Grinstead."

To set the system in operation, the microprocessor 17 is activated to set the fan 3 going. Once the fan 3 is determined to be operating correctly, the pilot valve 11 and the electronic ignition are activated. If after a predetermined time the flame

detector does not detect the existence of a pilot flame in the pilot burner, the system shuts down. Otherwise, the microprocessor 17 causes both the apertures 31 and 33 in the valve 12 to open. Gas is therefore drawn into the main burner wherein it is ignited by the pilot flame (or, if no pilot valve is used, by direct electric spark).

The main burner thus produces a stream of combustion products at a temperature of about 1000°C. These are swept through the tube 1 and heat the tube to the temperatures indicated thereon. At these temperatures, the majority of the tube 1 emits effective quantities of thermal energy as infra-red radiation.

The cooled combustion products are exhausted by the fan 3 and may be used, for instance, for heating water or for preheating the air being fed to the burner 5.

Once the thermostat 14 indicates that the air temperature has reached a preset level, the microprocessor 17 operates to close the second aperture 33. This reduces the amount of gas supplied to the main burner, which therefore produces less heat. The temperature of the tube 1 will therefore decrease slightly, but not sufficiently to reduce the efficiency of the radiation in heating the area to which it is directed.

The system described above may be changed to a continuously variable system by replacing the valve disc 37 by a tapered member which will allow the degree of opening of the aperture to be varied continuously in accordance with control signals from the microprocessor.

It will be appreciated that the present invention has been described above by way of example only, and that modifications can be made within the scope of the invention. In particular, the above described system can readily be adapted for use with straight or continuous tube systems.

CLAIMS

1. A radiant heating system comprising a tube, a burner for supplying combustion products to the tube, a fan for drawing the combustion products through the tube, and at least one swirler (or heat transfer plate) within the tube, the burner being connected to its fuel supply through a first aperture and a second aperture of a dual aperture valve, whereby, during operation of the burner, the first aperture provides on/off fuel supply to the burner, and the second aperture controls the rate of fuel supply to the burner.

2. The system of claim 1, wherein the fan is of variable speed to maximise combustion efficiency.

3. The system of claim 1 or claim 2, wherein the fuel supply is variable stepwise by the operation of the second aperture.

4. The system of claim 1 or claim 2, wherein the fuel supply is variable continuously between zero and a predetermined maximum by the operation of the second aperture.

5. The system of any one of claims 1 to 4, wherein the dual aperture valve is electrically or electronically controlled.

6. The system of any one of claims 1 to 5, wherein the opening of both the apertures is linked to the operation of the fan, whereby they may only be opened when the fan is operating.

7. The system of any one of claims 1 to 6, wherein the opening of both apertures is linked to a flame detector, whereby they may be opened when the pilot flame is burning.

8. The system of any one of claims 1 to 7, wherein the opening of the second aperture is linked to a thermostat.

9. The system of claim 8, wherein the second aperture is open when the thermostat temperature is below a preset limit and closed when it is above this limit.

10. The system of claim 8, wherein the opening of the second aperture is variable and is linked to the thermostat whereby its degree of opening is inversely related to the temperature within the area to be heated.

11. The system of any one of claims 1 to 10, which includes at least one reflector for directing heat to the desired area.

12. A radiant heating system, substantially as hereinbefore described with reference to the accompanying drawings.